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Towards resilient average consensus in multi-agent systems: a detection and compensation approach

Key words: Resilient consensus; Multi-agent systems; Malicious attacks; Detection; Compensation

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Motivation

1. The multi-agent systems are vulnerable to attack or failure. Minor failures or malicious attacks on consensus will have an unexpected impact on formation control and the execution of cooperative tasks. Resilient consensus algorithms have been widely investigated to ensure the security of distributed multi-agent systems under faults or malicious attacks.

2. It is important to design resilient average consensus algorithms for multi-agent systems to defend against the adverse impact on the consensus that is brought by misbehaving agents, including malicious and faulty ones.

Main idea

1. Based on two-hop communication information, we design detection–isolation–mitigation-based methods to detect and isolate misbehaving agents and compensate for the detected errors.

2. To achieve better performance of resilient average consensus, we compensate for the adverse impact of misbehaving agents with tolerance for faulty agents.

Method

1. A deterministic detection compensation based consensus (D-DCC) algorithm for normal agents is proposed by using two-hop communication information.

2. A stochastic detection compensation based consensus (S-DCC) algorithm is proposed to handle scenarios where communication links may fail due to accidents.

Major results

1. The D-DCC algorithm can detect the misbehaving agent (node 1), and the accurate average consensus is achieved with the remaining agents. The consensus achieved by D-DCC is more accurate than related studies.

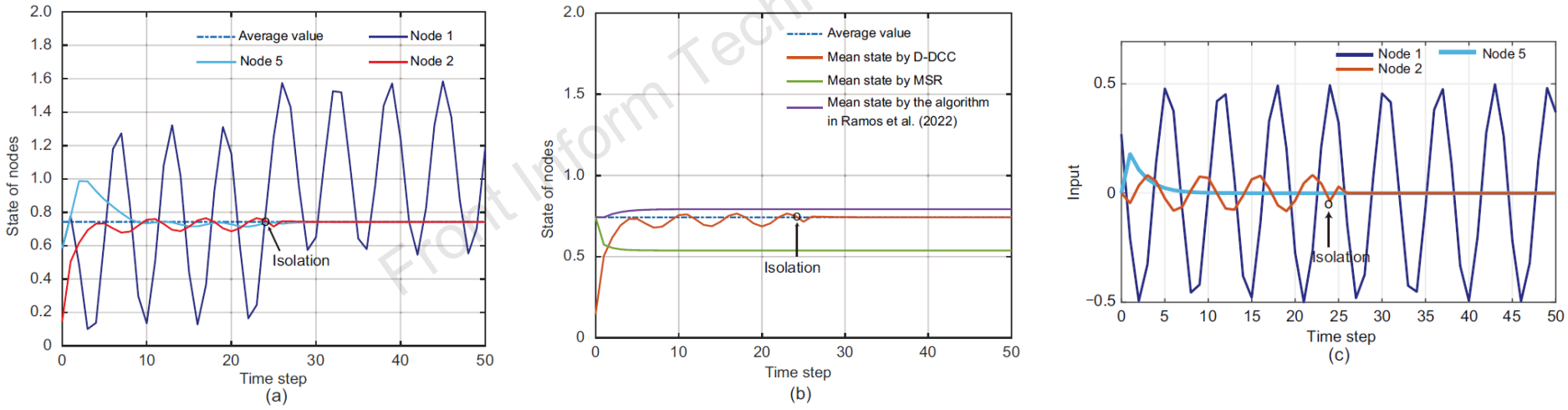

Fig. 2 Resilient consensus performance of D-DCC: (a) state evolution of the system; (b) system state under different methods; (c) error inputs of agents 1 and 5 and compensation of agent 2

Major results

2. The S-DCC algorithm can also detect misbehaving agent (node 1) , and achieve unbiased resilient average consensus in a statistical sense (node 2 and node 5). The consensus achieved by S-DCC is more accurate.

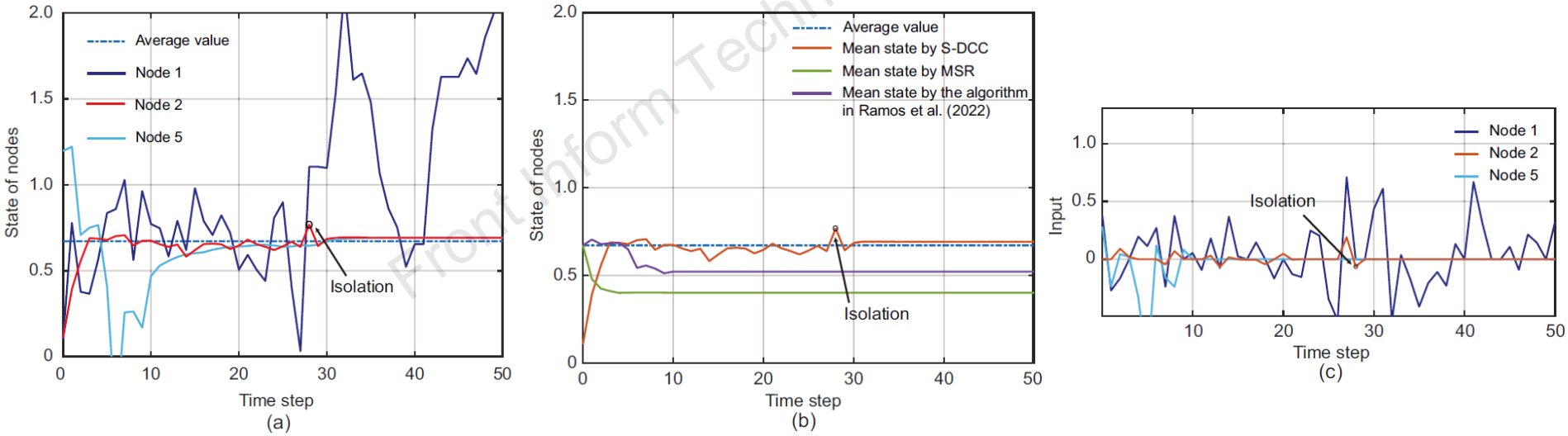

Fig. 4 Resilient consensus performance of S-DCC: (a) system state evolution; (b) system state under different methods; (c) error inputs of agents 1 and 5 and compensation of agent 2

Conclusions

1. The research introduces the D-DCC and S-DCC algorithms for detecting and mitigating misbehaving agents in multi-agent systems.

2. The D-DCC algorithm is designed to handle scenarios with reliable communication, effectively eliminating the negative impacts caused by misbehaviors. It turns out that it can achieve accurate resilient average consensus.

3. The S-DCC algorithm, proposed in this study, is capable of adapting to scenarios where communication link failures are possible. It is demonstrated to achieve unbiased resilient average consensus in a statistical sense.

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